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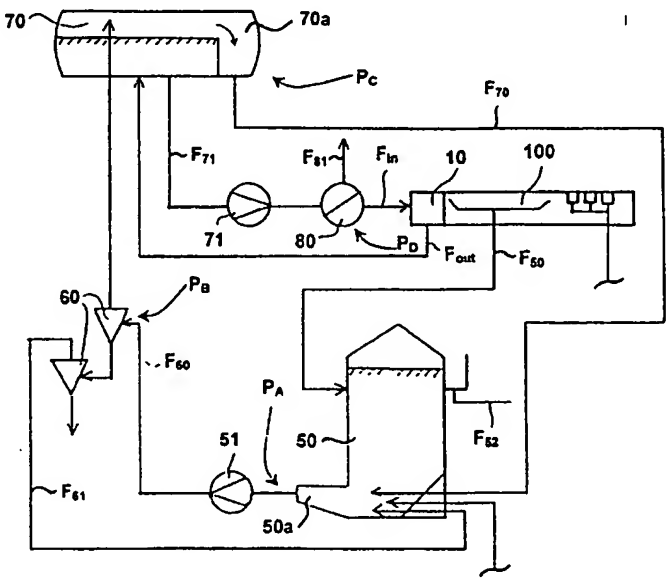
(54) Title: REGULATION SYSTEM FOR THE SHORT CIRCULATION AND HEADBOX OF A PAPER MACHINE OR EQUIVALENT



(57) Abstract: The present invention relates to a method for measuring and controlling the short circulation of a paper machine or equivalent and measurement and control of the headbox, said short circulation comprising apparatus for diluting thick stock into the headbox consistency, and apparatus for cleaning the stock to be fed into the headbox, and in which the headbox (10) comprises a stock inlet header, a tube bank, a turbulence generator and a slice channel. In the method, the measurement targets (P_A, P_B, P_C, P_D, 10) are provided with means for measuring the fibre mobility of the fibre suspension and, on the basis of the fibre mobility measured from the fibre suspension, the flow state of the fibre suspension is controlled. The invention also concerns the headbox (10) of a paper machine or equivalent, comprising a stock inlet header, a tube bank, a turbulence generator and a slice channel. In addition, the headbox comprises sensors on the width of the headbox (10) or a traversing sensor/sensors, which is/are positioned on different width points of the headbox (10) and that the sensor/sensors is/are arranged to measure the fibre mobility profile of the headbox and that the headbox (10) comprises means for changing the flow state on the basis of the measurement data obtained from the sensors. The invention also relates to a short circulation of a paper machine or equivalent, comprising apparatus for diluting the thick stock into headbox consistency and units for cleaning the stock to be fed into the headbox. The short circulation comprises also a sensor/sensors, being disposed in the short circulation pipes and/or cleaning units and that the sensor/sensors is/are arranged to measure the fibre mobility of the fibre suspension in the short circulation, and that the short circulation includes means for changing the flow state on the basis of the measurement data obtained from the sensors.

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Regulation system for the short circulation and headbox of a paper machine or equivalent

The present invention relates to a method in the measurement and control of the short circulation and the headbox of a paper machine or equivalent. The present invention relates also to a headbox and the short circulation.

The invention relates to the arrangement of the short circulation and the headbox of a paper machine or equivalent. The paper machine or equivalent refers in the present context to a machine with which paper-like product such as paper, board or tissue paper is produced.

The stock feeding of the paper machine is in general as follows. The stock components are stored in the paper mill in separate storage tanks, wherefrom they are fed into proportioning tanks and therefrom further into a common mixing tank, in which the stock components are intermixed. From the mixing tank the stock is fed into a machine tank, wherefrom the stock, being in general in about 3% consistency, is fed into a short-circulation wire pit. In the wire pit the thick stock is diluted into a headbox consistency, which is in general about 1%.

The fibres and fillers to be used as raw material are taken to the wire through a headbox and conveyed by water. The filtrate having passed through the wire, containing fibrous agents and fillers in great quantities, is returned as a filtrate of the thick stock from the machine tank back to the wire through the headbox. A flow link thus formed is called a short circulation.

Impurities may enter in the short circulation together with the thick stock or through other ways which have to be removed before the headbox. This is carried out with short-circulation cleaning apparatus, such as hydrocyclones, screens, machine screens and deaeration tanks.

The short circulation together with the headbox in connection therewith is in general considered as the most sensitive part of the papermaking process. Any small changes in the consistency, flow or other parameters immediately affect the quality of the paper being manufactured or cause web breaks on the paper machine. The function of the short circulation in the papermaking is, among other things, to produce a fibre suspension of uniform quality, in which the various components (fibre fractions, chemicals and fillers) are intermixed into a homogeneous fluid. The good homogeneity of the stock thus produced will guarantee a uniform quality in the paper and an undisturbed production process in subsequent phases.

In the papermaking, one of the important functions of the headbox is formation of slice jet to be optimal in its flow state. In an optimal slice jet, the solid matter is distributed homogeneously, the floc size is optimal, the disturbances are minimal, and the turbulence level is under control. The essential measurable and controllable quantity is the degree of suspension fluidization, illustrating the intermobility of fibres. In the headbox, various geometrical designs are used for fluidizing the suspension, such as step changes of flow channels, adjustments of trailing elements and various surface phenomena, such as boundary layer turbulence, wherewith turbulence is generated in the flow of the suspension.

In the prior-art OptiFeed process of the applicant, described in patent specification FI-103676, the stock entering the paper machine is built from a number of separate (2–4) stock components, the fibrous properties of which deviate from each other and vary along with changes of the paper grade to be manufactured. The stock components are mixed into homogeneous fluid in so-called mixing reactors located in the parts of the short circulation to which several stock components are brought simultaneously.

The operation of the OptiFeed process is dependent on the goodness of the operation of the mixing reactor. In an optimal situation, the mixing should be as perfect as possible and in addition, to work for all paper grades being manufactured, even though the flow quantities of different components, depending on the quality, may

vary to a great extent. The goodness of the mixing of different components being mixed as known in the art can be measured and controlled when an optimal operation is to be secured. The mixability of suspensions containing fibrous matter is dependent on the mobility of solid matter and the turbulence generated therethrough. Optimizing the generation of turbulence is implementable e.g. by means of various adjustable throttling elements, disclosed e.g. in the patent application of the applicant No. FI-992015.

In the flow of fibre suspension, the fibres tend to form accumulations called flocs. If the consistency of the flow exceeds the sedimentation consistency, the flocs are built into a net-like united phase, which in the papermaking is an undesired state. The state in which the structure is completely decomposed is called fluidized. In mixing a fibrous suspension, momentary fluidization of components to be mixed is expected. The mixing is in general carried out by conducting flows of different components into one at different speeds. If the state of fluidization can be monitored, the differential speed required (shearing stress between the flows being mixed) can be set optimal. In connection with the fluidization, the structure of a fibre net or flocs is decomposed. Hereby, the state of fluidization can be estimated with the aid of floc size and its completeness with the aid of the minimum size achieved. The floc size measuring in the process circumstances is very difficult in practice.

Generating turbulence in the fibre suspension causes breaking up of fibre flocs and increased intermobility of individual fibres. Providing fluidization by increasing the turbulence requires geometric changes to add shearing stresses or a surface of a flow channel or a trailing element to produce sufficient boundary-layer turbulence. Increased fluidization as such will not cause reduction of turbulence. The fibre suspension usually tends to become re-flocculated so to speak, which can be observed as reduced fibre mobility (degree of fluidization). On the other hand, the properties of turbulence include so-called dissipation, which means changing of the kinetic energy of the turbulence into internal energy (heat) of the fluid. However, the degree of fluidization of the suspension will be de-

creased owing to the dissipation of turbulence. Thus, the fluidization of the suspension is a transient state, the follow-up of which is essential for the success of the papermaking process.

The objective of the present invention is to develop a method and an apparatus for real-time measuring of the short circulation of a paper machine or equivalent and of the fibre mobility of the suspension of the headbox and for controlling the flow state.

The objective of the present invention is also to provide a method and an apparatus, wherewith as optimal mixability of the fibre suspension as possible is guaranteed in different parts of the short circulation and the headbox so that the fibre suspension is in an optimal state for the subsequent phase of the process.

The method according to the invention is mainly characterized in that in the method, the selected measurement targets are provided with means for measuring the fibre mobility of the fibre suspension, and on the basis of the fibre mobility measured from the fibre suspension, the flow state of the fibre suspension is controlled..

The headbox of the invention is in turn characterized in that the headbox comprises sensors on the width of the headbox or a traversing sensor/sensors, being fitted in different width points of the headbox, and that a sensor/sensors is/are arranged to measure the fibre mobility profile of the headbox on the width of the entire headbox and that the headbox comprises means for changing the flow state on the basis of the measurement data obtained from the sensors.

The short circulation of the invention is characterized in that the short circulation comprises a sensor/sensors, disposed in the pipes of the short circulation and/or in the cleaning apparatus, and that a sensor/sensors are arranged to measure the fibre mobility of the fibre suspension in the short circulation and that the short circula-

tion comprises means for changing the flow state on the basis of the measurement data rendered by the sensors.

According to the invention, the apparatus components used for controlling the mixture in the short circulation of a paper machine or equivalent are provided with sensors measuring the flow state, on the basis of the data obtained wherefrom the flow state is controlled by means of control devices. With a measurement and control system such as this, the furnish of the fibre suspension is controlled to be such that it is optimal for the next process phase. The solution according to the invention can be used also in cardboard and tissue machines.

In addition, with the method according to the invention, the fibre mobility of the suspension of the headbox can be measured most precisely on the entire width of the slice channel. The slice channel is provided with a row of sensors, a sensor matrix or a traversing sensor, in which the degree of fluidization of the suspension is measured in real time. In multiple-layer headboxes, a row of sensors or a sensor matrix is positioned on each layer. On the basis of the measurement data obtained from the sensors, the flow state of the suspension of the headbox is controlled, in order to make the fibre mobility, that is, the degree of fluidization, optimal. When the optimal range of variation of the fibre mobility is known for different paper grades, the quality of the paper produced can be controlled in changing running circumstances. The optimal range of variation of the fibre mobility can be determined experimentally.

The invention is described more in detail with reference to the accompanying figures, in which

Figure 1 is a principle block diagram representation about measurement and control of solid matter mobility in the short circulation.

Figure 2 presents development of fibre mobility as a function of residence time t.

Figure 3 presents a short circulation process arrangement.

Figure 4A presents an example of the structure of a short circulation mixing reactor.

Figure 4B presents an actuator for controlling the mixing in a short circulation mixing reactor with the actuator in open position.

Figure 4C presents the actuator of Fig. 3B in partly closed position.

Figure 5 presents an example of positioning a sensor matrix of the invention in the slice area of the headbox and the control system of the invention.

Figures 6A, 6B and 6C present one embodiment of a turbulence adjuster sleeve to be disposed in a flow channel.

Figures 7A and 7B present a second embodiment of a turbulence adjuster sleeve to be disposed in a flow channel.

Figure 1 presents a model for optimizing the mixing of fibre suspension. On principle level, Fig. 1 presents a mixing reactor MR equivalent to the part of the short circulation to which one or more components C_1, C_2, C_3, C_4 are supplied to be mixed in the mixing reactor MR into as uniform mixture as possible. The fibre properties of the components C_1, C_2, C_3, C_4 to be mixed deviate in general from each other and their mutual ratio varies according to the paper grade to be produced. The components C_1, C_2, C_3, C_4 to be mixed are mixed in a controllable mixing element ME. According to the invention, in the volume after the mixing element ME, a mixing sensor MS is positioned to measure the homogeneity of the mixture. From the output of the mixing reactor MR, a stock flow mix is obtained, which is controlled so that its furnish is optimal as possible for the subsequent phase of the process. From the sensor MS, a measuring signal S_1 is obtained which is taken to the mixing control unit MC to send a control signal S_2 to a mix-

ing element MR_1. In this manner a feedbeck is formed with which the control of the furnish of the invention can be carried out.

In the measurement and control system described above, the sensors to be used for measuring a flow state are e.g. rapid pressure sensors measuring pressure variations or surface friction sensors measuring acceleration. Also with different optical methods, with e.g. laser-Doppler anemometer, fibre mobility can be measured, as well as with sensors based on radioactive radiation, microwave measurement or ultrasonic sensors. On the basis of the measured fibre mobility data, turbulence is brought into a flow state, wherewith the mobility of the fibre suspension is controlled to be optimal. The volume being measured from the fibre suspension in a target being measured is tried to be selected so that it is the smallest element in which the fibres and other ingredients are mixed uniformly. The size of such volumetric element is dependent, for instance, on the medium length of fibres and its ideal size varies in different parts of the process and is dependent the product being produced.

When the fibre mobility is measured with methods described above, information is obtained on the mobility of individual fibres, which has been found to describe well the level of floc size and fibre network forming. Indirect data can be obtained from the fibre mobility about the intensity of the turbulent movement of fibres, about the parameters of the location correlation and the parameters concerning the shape of the velocity distribution. The graph depicted in Fig. 2 describes the intensity I of the movement of fibres of the fibre suspension, that is, development of the fibre mobility as a function of the residence time t. The intensity I of the fibre movement is inversely proportional to the floc volume. The graph is divided into four parts, in part 1 of which the fibre mobility of the fibre suspension is presented before fluidization, whereby the floc size is great and the mobility of fibres small. In part 2, the fibre suspension is fluidized, whereby the fibre mobility increases and the floc size reduces. Thereafter, re-flocculation follows in part 3, whereby the fibre mobility reduces as a function of time, until the flow state ends into a

saturation state in part 4, in which the fibre mobility no longer significantly diminishes.

Figure 3 presents a short-circulation process arrangement, in which such process targets are presented in which the measurement and control arrangement of the mixing presented in Fig. 1 can be applied.

As shown in Fig. 3, the headbox 10 in short circulation feeds through its slice opening a stock suspension jet into the wire section 100. From the wire section 100, the water collecting apparatus conduct the water discharged through the wire as a flow F_{50} into the wire pit 50. To the mixing area 50a of the mixing pit 50, a fresh stock flow M_T is fed, the consistency whereof being in general of the order 3%. While in the wire pit 50, the fresh stock is diluted into headbox consistency of the order 1%. To the mixing area 50a of the wire pit 50, the suction side of a pump 51 is connected. From the pressure side of the pump 51, a stock flow F_{60} diluted into the headbox consistency is directed through the hydrocyclones 60 to a deaeration tank 70.

In the deaeration tank 70, the air volume prevailing in underpressure is located above the free surface of the stock. The height of the stock surface is determined by the overflow 70a of the deaeration tank 70, across which a stock flow F_{70} is flowing, from which the air is removed. Said stock flow F_{70} is conducted to the mixing area 50a of the wire pit 50. In addition, a return flow F_{61} is brought into said mixing area 50a from the accept of the second phase hydrocyclones, and a fresh stock flow M_T. From the lower part of the deaeration tank 70, a stock flow F_{71} is conducted to the suction side of the pump 71. The pump 71 feeds the inlet stock flow F_{in} through the machine screen 80 to the stock inlet header of the headbox 10. The bypass F_{out} of the stock inlet header of the headbox 10 is returned to the deaeration tank 70. Reject F_{81} of the machine screen 80 is conducted to treatment of rejects.

According to the invention, targets appropriate for measuring and controlling the flow state in short circulation are the positions marked in the figure; in position P_A

in connection with the mixing area 50a of thick stock and wire water, in position P_B in connection with the hydrocyclone unit 60, in position P_A in connection with the deaeration unit 70, in position P_D in connection with the machine screen 80.

Figure 4A presents a mixing reactor MR, in which the control of the flow state according to the invention is implemented in the short circulation. Into the mixing reactor MR, two or more components C_1, C_2, ..., are brought to be mixed, which are tried to get mixed into as homogeneous stock mix F_{mix} as possible. Said mixable components are for instance, thick stock and wire water.

Figure 4B presents an actuator with which the control of the flow state of the invention can be implemented in mixing reactors MR located in different process phases of the short circulation, in which the components C_1 are mixed in the outer pipe t_1 and the C_2 in the inner pipe t_2. Component C_1 is e.g. thick stock and component C_2, wire water. According to the invention, in the outlet end of the inner pipe t_1 of the mixing reactor, so-called delta wings d_i are installed, the angle whereof being controllable with an exterior control. The outlet end of pipe t_1 comprises six delta wings d_i in the present example, the angle of which is controlled by means of control actuators d_C. There may be also some other number of delta wings d_i available. By opening the delta wings d_i, the outer flows can be restricted.

By closing the delta wings d_i, the inner pipe can be closed partly or entirely, so that no harmful dead volume is left in the inner pipe. The shape of the delta wing of the design of the invention is a highly efficient turbulence generator. Figure 4C presents a delta wing structure of the invention, in which the delta wings d_i limit more the flow of the inner pipe t_1.

In addition to what is described above, also other control means can be used for controlling the flow state in the short circulation. Such means are for instance controllable pipe expansions positioned before the cleaning units (hydrocyclones, deaeration tanks), in which the diameter of the pipes and or the location of a pipe

expansion can be adjusted, and controls to be implemented in the machine screen, in which the wing angle, distance of the wing, pressure and/or speed of rotation can be controlled. In addition, controllable throttles can be positioned before the cleaning units.

Figure 5 presents the headbox 10 of a paper or board machine, comprising a stock inlet header J, tube bank 11, an intermediate chamber 12, a turbulence generator 13 and a slice channel 14. The headbox 10 is provided with a row of sensors or sensor matrix $S_{11},...,S_{nm}$, in which the overall number of sensors is n x m. In the embodiment of Fig. 4, the sensors $S_{11},...,S_{nm}$ are attached to the slice channel 14 so that the sensors S extend on the width and length of the slice channel 14. With the sensors S, the mobility of suspension fibres are measured and the sensors S are positioned preferably at equal distances e.g. 60 mm from each other. The sensors S can be positioned on the upper and lower surface of the slice channel in one-layer headboxes. In multi-layer headboxes the sensors S can be positioned on each layer. With one row of sensors, a momentary transverse profile illustrating the mobility of fibres can be measured. Using a sensor matrix, information can be moreover received about the fibre mobility in machine direction. The sensors $S_{11},...,S_{nm}$ are attached to e.g. a slice cone, on the surfaces of the trailing elements or the tube bank and measuring signal leads are drawn therefrom to the receiving unit 20 processing the measurement data and transmitting it to the control unit 30 of the headbox. It is also possible to use a traversing sensor which keeps moving in cross-machine direction.

The mode of operation of the fibre mobility sensors can be based on a number of different quantities. The measurement can be performed e.g. on the basis of rapid pressure variations, whereby pressure sensors are used, or one the basis of acceleration, whereby surface friction sensors are used. Using various optical methods, e.g. laser Doppler anemometer, fibre mobility can be measured like with sensors based on radioactive radiation, microwave measurement or ultrasonic measurement. On the basis of the fibre mobility data measured, such turbulence is gener-

ated in the flow state, with which the mobility of the fibre suspension is controlled to be optimal.

The headbox control unit 30 controls the transverse control of turbulence according to the invention in the headbox. For controlling the turbulence, a plurality of different methods and apparatus are known in the art. In US. patent specification No. 4,133,713, an arrangement is disclosed in which the turbulence is controlled by changing the length of the trailing element. Turbulence can also be generated by means of various geometric designs, such as step changes of flow channels and by means of flow channel surface structure (e.g. surface roughness, materials).

Figures 6 and 7 present a turbulence adjuster sleeve T to be disposed in the flow channel, wherewith the turbulence is adjusted with two nested sleeves T_1 and T_2 so that the inner sleeve T_2 is moved by rotating and/or pushing it relative to the outer sleeve T_1. The inner sleeve T_2 has a geometrical form wherewith an abrupt change is produced in the flow state and thus, turbulence at said point. Adjuster sleeves T can be positioned e.g. in the channels 13_{a11}, 13_{a12},... of the turbulence generator.

Figure 6 presents more in detail a first way of adjusting the adjuster sleeve T of the invention, in which the flow state is changed by rotating the inner sleeve T_2. Figures 6B and 6C present section C–C of Fig. 6A, in which the inner sleeve T_2 is adjusted into two different positions for controlling the degree of turbulence.

Figure 7 presents a second adjustment form of the adjuster sleeve T. In this embodiment, the sleeve disposed within the flow pipe is moved in machine direction, so that the adjustment is produced in the generation of the turbulence caused by the sleeve. In Figs. 7A and 7B, by pushing the adjuster sleeve T disposed within the flow pipe V into different directions, a change can be produced in the flow state.

The rotation of the sleeve relative to its axis and/or moving it in machine direction generates controlled changes in the strength and orientation of turbulence. By said mechanisms, e.g. control of turbulence intensity is obtained after the turbulence generator, that is at the beginning of the slice channel. Hence, it is also possible to profile the turbulence and consequently, also the fluidization of the suspension in cross-machine direction and/or in Z direction.

In the following, the patent claims will be given, and different details of the invention can show variation within the scope of the inventive idea defined in said claims and differ from what has been stated above by way of example only.

Claims

1. A method for measuring and controlling the short circulation and/or the headbox of a paper machine or equivalent, said short circulation comprising apparatus for diluting thick stock into headbox consistency and apparatus for cleaning the stock to be fed into the headbox, and where the headbox (10) comprises a stock inlet header (J), tube bank (11), a turbulence generator (13) and a slice channel (14), **characterized** in that in the method, the selected measurement targets (P_A, P_B, P_C, P_D, 10) are provided with means for measuring the fibre mobility of the fibre suspension, and on the basis of the fibre mobility measured from the fibre suspension, the flow state of the fibre suspension is controlled.

2. Method according to claim 1, **characterized** in that the flow state is arranged in each measurement target (P_A, B_B, P_C, P_D, 10) so that the flow state becomes optimal for the next part of the process.

3. Method according to claim 1 or 2, **characterized** in that for the means for measuring the flow state, pressure sensors, acceleration sensors, measuring devices based on optical phenomena, sensors measuring radioactive radiation, ultrasonic sensors or microwave sensors are used.

4. Method according to any one of claims 1 to 3, **characterized** in that in measuring the flow state, the smallest state is selected for the size of the state to be measured, in which the fibres and other ingredients are mixed uniformly.

5. Method according to any one of claims 1 to 4, **characterized** in that for the means for controlling the flow state, a mixing reactor (MR) is used which is provided with delta wings (d_i), the wing angle of which is adjusted.

6. Method according to any one of claims 1 to 5, **characterized** in that for the measuring and control target of the flow state in the short circulation, the mixing

area of wire water and thick stock (P_A), a hydrocyclone unit (P_B), a deaeration unit (P_C) and/or a machine screen (P_D) is used.

7. Method according to any one of claims 1 to 6, **characterized** in that the headbox (10) is provided with fibre mobility sensors (S), forming a row of sensors or a sensor matrix in transverse direction to the headbox or with traversing sensor/sensors (S) used for determining the transverse fibre mobility profile of the headbox, and on the basis of the transverse fibre mobility profile determined, the flow state of the headbox is controlled.

8. Method according to any one of claims 1 to 7, **characterized** in that the fibre mobility sensors (S) are positioned on the surface of trailing elements or in a slice channel (14) or a tube bank (11).

9. Method according to any one of claims 1 to 8, **characterized** in that the fibre mobility sensor (S) is moved in cross-machine direction.

10. Method according to any one of claims 1 to 9, **characterized** in that the flow state of the headbox is controlled with step changes of the flow channels or with a flow channel surface structure or by adjusting the length of the trailing elements or with adjuster sleeves (T) disposed in the flow channels.

11. Method according to any one of claims 1 to 10, **characterized** in that the flow state of the fibre suspension is controlled before and/or after a fibre mobility measurement.

12. A headbox of a paper machine or equivalent, comprising a stock inlet header (J), a tube bank (11), a turbulence generator (13) and a slice channel (14), **characterized** in that the headbox comprises sensors on the width of the headbox (10) or a traversing sensor/sensors (S), being fitted in different width points of the headbox (10), and that a sensor/sensors (S) is/are arranged to measure the fibre mobility profile of the headbox on the width of the entire headbox (10) and that the

headbox (10) comprises means for changing the flow state on the basis of the measurement data obtained from the sensors (S).

13. A headbox according to claim 12, **characterized** in that the sensors (S) are disposed in the slice channel (14) of the headbox (10) on the width of the slice channel (14).

14. A headbox according to claim 12 or 13, **characterized** in that the sensors (S) are arranged into a matrix disposed in the slice channel (14) of the headbox (10) on the length of the slice channel (14).

15. A headbox according to any one of claims 12 to 14, **characterized** in that the headbox (10) comprises means for controlling the transverse turbulence profile of the headbox (10).

16. A headbox according to any one of claims 12 to 15, **characterized** in that the turbulence generator (13) of the headbox (10) is provided with adjuster sleeves (T) for controlling the transverse turbulence profile of the headbox (10).

17. Short circulation of a paper machine or equivalent, comprising apparatus for diluting the thick stock into headbox consistency and apparatus for cleaning the stock to be fed into the headbox, **characterized** in that the short circulation comprises a sensor/sensors (MS), disposed in the pipes of the short circulation and/or in the cleaning apparatus, and that a sensor/sensors are arranged to measure the fibre mobility of the fibre suspension in the short circulation and that the short circulation comprises means for changing the flow state on the basis of the measurement data rendered by the sensors (MS).

18. Short circulation according to claim 17, **characterized** in that the sensors (MS) are arranged in the mixing area of thick stock and wire water (P_A), in the hydrocyclone unit (P_B), in the deaeration unit (P_C) and/or the machine screen (P_D).

19. Short circulation according to claim 17 or 18, **characterized** in that the flow state of the fibre suspension is controlled before and/or after a fibre mobility measurement.

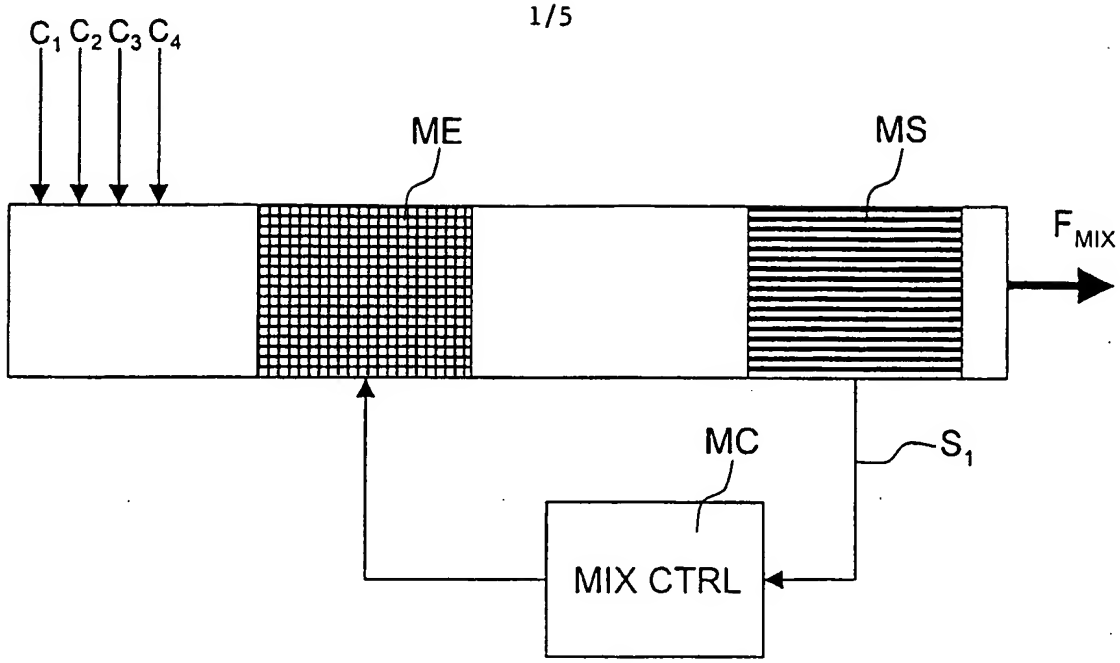


FIG. 1

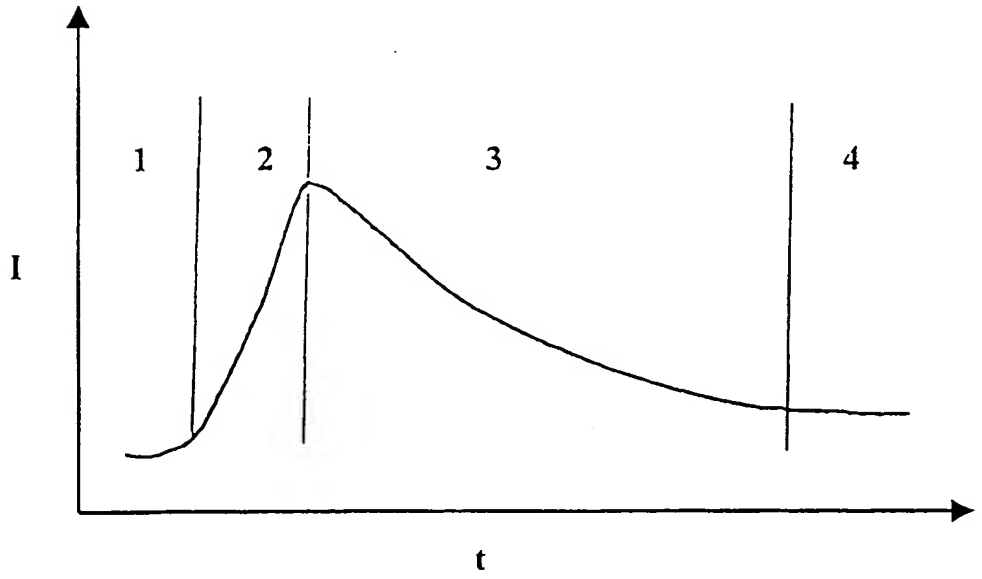
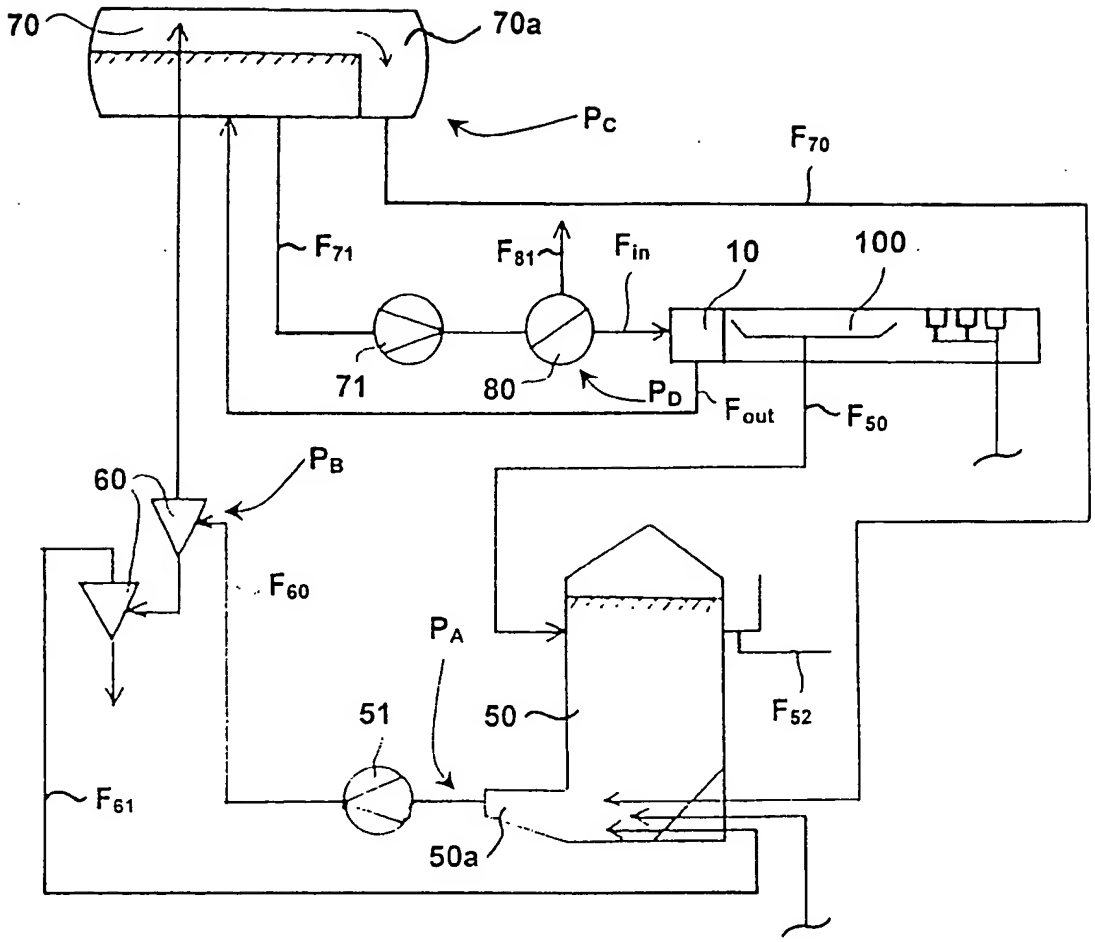


FIG. 2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Pc
F70
F71
F81
Fin
10
100
71
80
PD
Fout
F50
60
PB
F60
PA
51
50
F52
F61
50a

FIG. 3

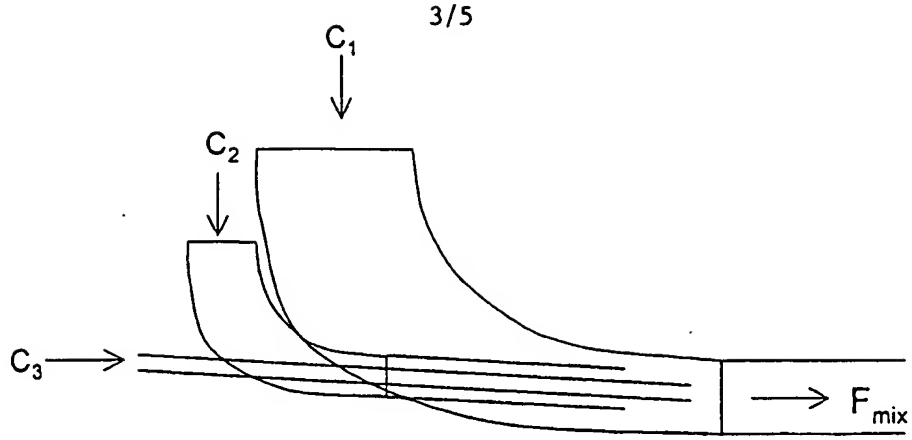

FIG. 4A

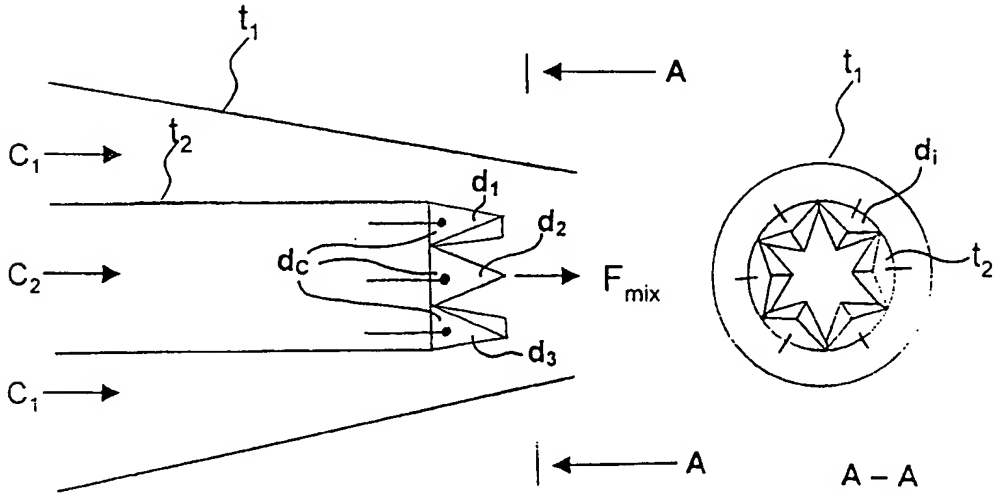

FIG. 4B

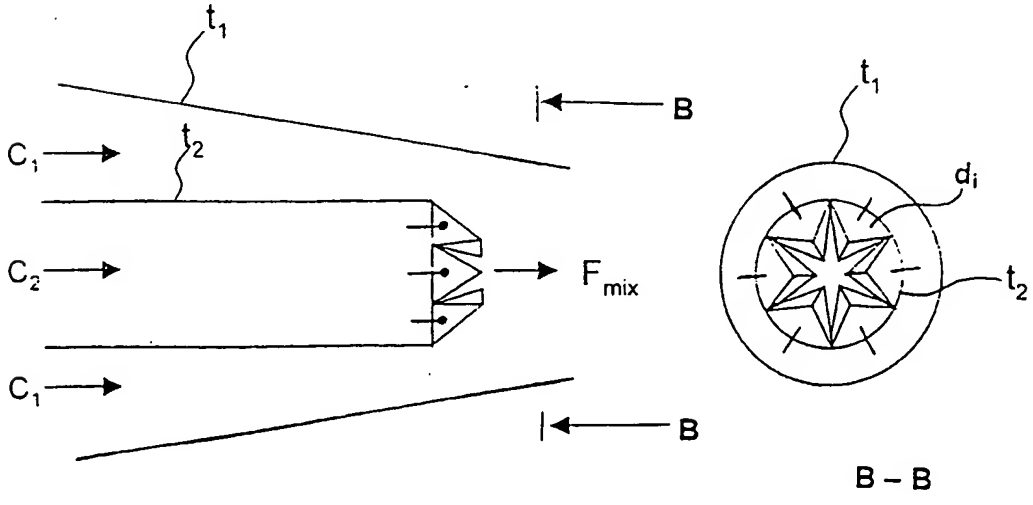

FIG. 4C

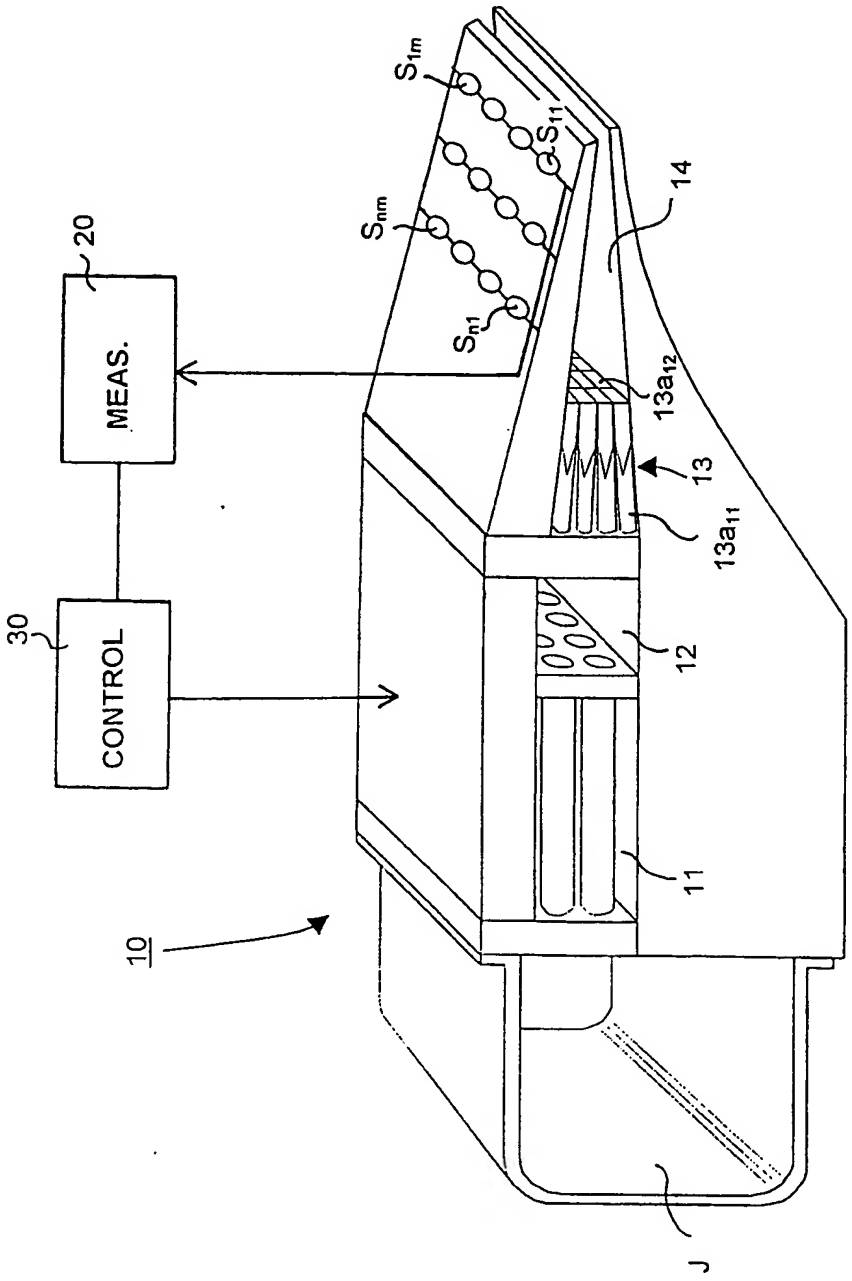

FIG. 5

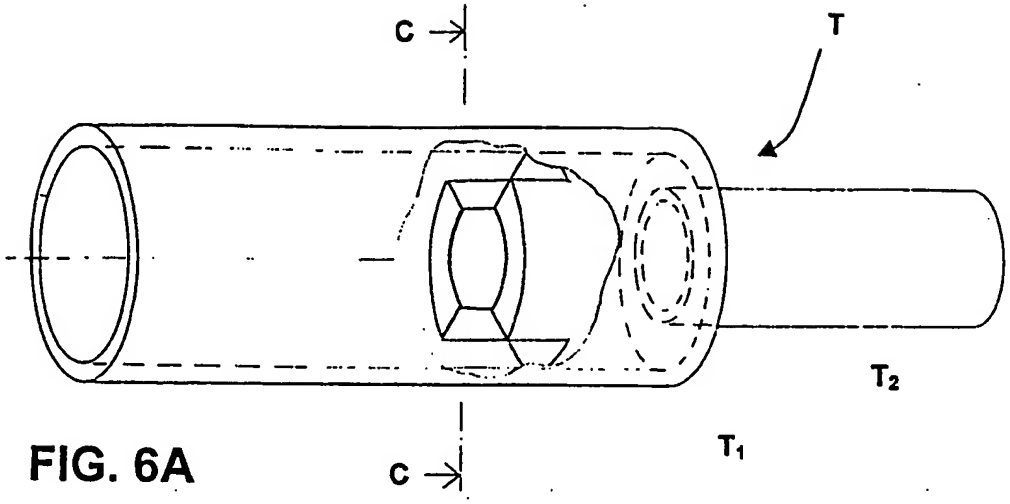

FIG. 6A

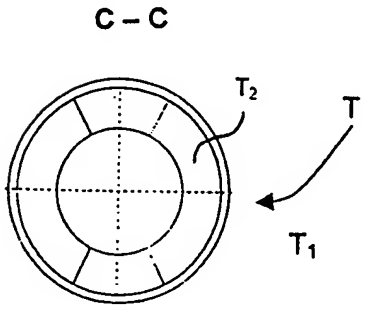

FIG. 6B

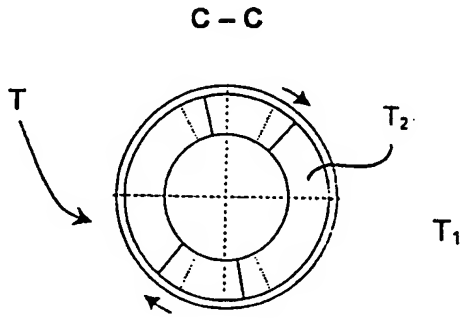

FIG. 6C

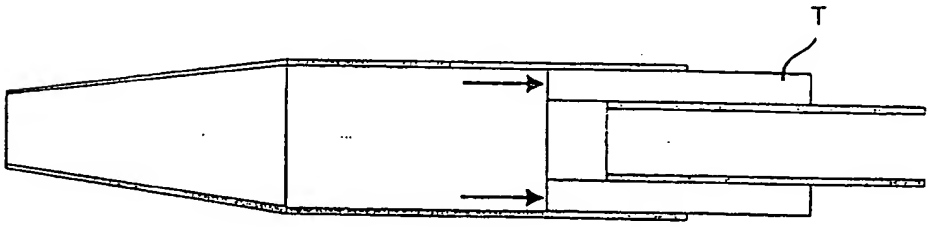

FIG. 7A

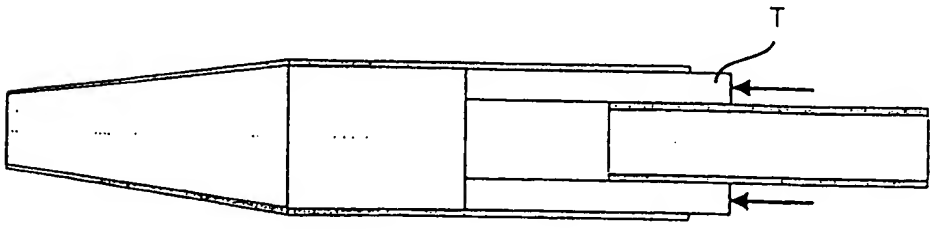

FIG. 7B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00797

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: D21F 1/02, D21F 1/66
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: D21F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Tappi Journal, Volume 78, No 2, February 1995, Richard J. Kerekes et al, "Effects of fiber length and coarseness on pulp flocculation", page 133 - page 139, see page 134 - page 135	1-19
A	US 3573160 A (KASIMIR LOPAS), 30 March 1971 (30.03.71), column 5, line 23 - line 43	1-19
A	GB 2201173 A (SULZER ESCHER WYSS GMBH), 24 August 1988 (24.08.88), claim 1	1-19

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search
2 February 2001

Date of mailing of the international search report
05 -02- 2001

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INTERNATIONAL SEARCH REPORT

Information on patent family members

27/12/00

International application No.
PCT/FI 00/00797

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3573160 A	30/03/71	NONE	
GB 2201173 A	24/08/88	AT 344987 A	15/05/90
		AT 391719 B	26/11/90
		CH 671418 A	31/08/89
		DE 3715329 A	01/09/88
		FI 880290 A	24/08/88
		GB 8803306 D	00/00/00
		SE 8800607 D	00/00/00